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(12) (19) (CA) **Demande-Application**

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(86) 1996/12/19
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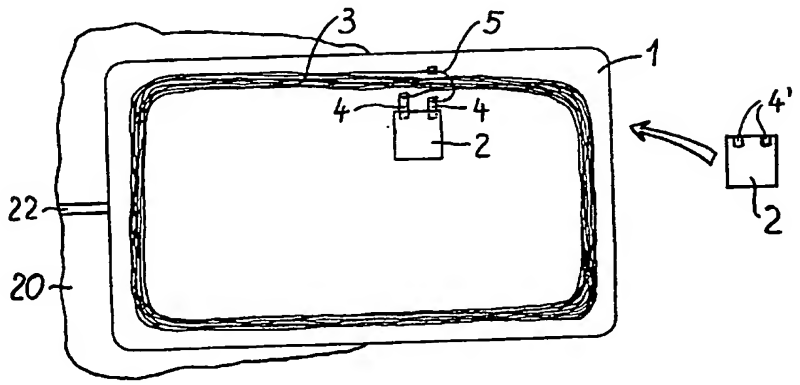
(54) PROCEDE DE PRODUCTION D'UNE CARTE A PUCES POUR UTILISATIONS SANS CONTACT

(54) PROCESS FOR PRODUCING A CHIP CARD FOR CONTACTLESS OPERATION



(57) L'invention concerne des cartes à puces devant comporter, outre des éléments de commutation intégrés (puce 2 et/ou module électronique 12) et des éléments de couplage (bobine 6, lamelles pour condensateur 8) pour la transmission sans contact d'énergie et/ou de données, au moins une étiquette (1) qui constitue une surface extérieure de la carte. Les éléments de couplage (6, 8) sont appliqués sur la face intérieure de cette étiquette. L'étiquette (1) ainsi obtenue est ensuite introduite dans un moule pour moulage par injection. Les éléments de commutation (12) intégrés préparés séparément sont ensuite positionnés en ajustement précis dans le moule

(57) In the chip cards to be produced, besides the integrated circuit components (chip 2 and/or electronic module 12) and coupling means (coil 6, capacitor coatings 8) for contactless power and/or data transmission there is also at least one label (1) forming the outer surface of the card. The coupling means (6, 8) are applied to the inner side of said label. The label (1), thus prepared, is then inserted into an injection mould. The separately prepared integrated circuit components (12) are then positioned accurately in the mould via terminals in the coupling means (6, 8) and contacted with them. Finally the card body is moulded on the label (1)

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par l'intermédiaire de connexions des éléments de couplage (6, 8) et sont mis en contact avec eux. Pour finir, le corps de la carte est moulé sur l'étiquette (1) par moulage par injection et les éléments de commutation (2, 12) sont simultanément moulés dans le corps de la carte. Des connexions électriques entre les éléments de couplage (6, 8) et les éléments de commutation (12) intégrés sont produites dans le moule même par différents moyens.

by the injection moulding process and the integrated circuit components (2, 12) are moulded into the card body. Electric connections between the coupling means (6, 8) and the integrated circuit components (12) are produced in the mould itself by various means.

FILE THIS AMENDED
~~TEXT~~ TRANSLATION

Sempac SA, 6330 Cham (Switzerland)

Method of manufacturing chip cards for use in non-contact technology

Background

Besides the well-known chip cards that have an external contact area and communicate through this with a read (and write) unit, so-called non-contact chip cards have also been proposed. These do not need an electrical contact between the card and the card reader unit, at least not for data transfer. Instead, transmission or communication is effected by means of coupling elements integrated in the card and in the card reader unit. Depending on the application, this technique makes a distinction between close coupling that requires the introduction of the card in a card reader, and remote coupling that permits communication over medium and greater distances "in passing", i.e. without the introduction of the card in a card reader. In addition to the predominant inductive coupling method (which is said to make not only data transfer possible, but also to provide a non-contact power supply for the card's circuitry), capacitative coupling has also been proposed, but this is considered only adequate for data transfer. Finally, cards for non-contact use that, in addition, have the conventional external contact area — so-called hybrid or combined cards — have also been proposed (see: Sickert, K., and Weinerth, H.: Schlüsseltechnologie Mikroelektronik, 24. Teil: Von der kontaktbehafteten zur kontaktlosen Chipkarte [Key technology Microelectronics, part 24: From

contact to non-contact chip cards]; Elektronik 1989, no 25, pp 66-78).

~~Prior art~~

Numerous applications for non-contact chip cards have already been proposed, and the relevant, highly sophisticated transfer and circuit systems, chips, and software have been developed for these. But thus far only few proposals have been published for the manufacture and construction of such cards that take into proper account the peculiarities of non-contact data transfer and energy transmission.

One such proposal provides for a card of laminate construction of several layers welded to one another, such as printed cover films and/or labels, that has an internal substrate of film or foil, with strip conductors, two small transmission coils for close coupling, and chips. In this type a ring surrounds a chip, apparently for mechanical protection (see: publication referred to, pp 75-76, figure 8 right and figure 10). Apart from the precise fit that is required in the superimposition of several layers of film or foil, welding together such large areas seems to create problems as regards the embedded chips and the printed outer layers of film or foil.

Another proposal provides for a single 4mm x 4mm chip with a hybrid circuit and a high-frequency antenna coil fitted to the back of the chip. Similarly to the proposal referred to above, the card consists of a stack of several layers of film or foil, and the chip has to be placed in a recess in an internal film or foil (Jurisch, R.: mic3 — die neue kontaktlose Chipkarten-technologie [mic3, the new non-contact chip-card technology]; Card-Forum 1995, no 3, pp 82-84). The reservations stated above as regards multi-layer construction also apply to this but, above all, the chip offers only an extremely limited area for the antenna coil, and this fact is in any case likely to make remote-coupling applications impossible.

amendments

Prior art

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From EP-A-0 682 321 a method for the manufacture of a chip-card is known which contains inductive coupling means for the contactless transmission of energy and/or data and which also contains integrated-circuits in form of at least one chip and/or electronic module. For at least one outer surface of the card a cover layer or a label is used where onto the one surface that faces away from the printed outer surface the aforesaid coupling means are applied. According to this

prior art too the body of the card is manufactured from several stapled layers by laminating.

Summary of disclosure

The object of the invention is to make possible the efficient, low-cost, and reliable serial production of non-contact chip cards, whereby at the same time the special requirements of coupling elements for non-contact operation are taken into account and also risks to the expensive special chips during the production process are avoided as far as possible.

The object of the invention is solved by a method of manufacturing according to the features of claim 1.

The outer surface of the labels used...

The outer surface of the labels used should preferably be preprinted, but blank labels may also be used and the finished cards printed subsequently as necessary. Coils and capacitor layers are both suitable for use as coupling elements, and elements for inductive and capacitative coupling may be comprised in a single card. For present purposes the term "electronic module" applies to a prefabricated unit that fits into the card and has at least one chip with a protective envelope and connector contacts. If a label is provided for each of the card's outer surfaces, either or both these labels may be prepared for insertion in the mould in the manner referred to above.

The method according to the present invention gives the label, which as a rule is necessary anyway, an advantageous double function. The coupling elements can be designed and arranged on the label in a great variety of ways without hampering handling, such as stacking, destacking, and introduction in the mould. Practically the entire surface of the label or card is available for the coupling means and thus it is possible to provide the requisite coil area and number of windings for remote coupling or to provide the capacitor layers for capacitative coupling. For precise positioning of the modules or chips within the mould, tools such as manipulators are available that have already proved their efficiency in the production of conventional chip cards. Moreover, injection moulding is an efficient process technique for the production of chip cards and ensures the gentle, yet firm embedding of chips and modules in the body of the card.

Several special versions of the method according to the invention as defined in claim 1 are referred to in the dependent claims. Typical embodiments of the present invention are described below in greater detail, by reference to and in conjunction with the drawings.

Brief description of drawings

Figures 1 to 4 inclusive show various typical embodiments of labels with coupling means arranged on the inner surface which, after introduction in the injection mould, are fitted and contacted in various ways with integrated-circuit elements; and

Figure 5 shows a partial section of an injection mould in which labels and integrated-circuit elements have been placed in readiness for the injection-moulding process.

Detailed description of invention

Figures 1 to 4 each show the inner surface of a label 1 as used in the production of chip cards to form the outer surface of the card. This is plastic film or foil in card format, typically about 0.1mm thick, that usually acts as a substrate for a printed text and/or image. Often two such labels form the two outer surfaces of a chip card. The outer surface of the label — not visible in these figures — is preferably preprinted, but subsequent printing of the finished card is also possible.

In all four embodiments, the surface shown is the side of the label that faces away from its outer surface. Coupling means 3, 6, 8 for non-contact use or operation of the card are applied to this inner surface. As indicated only in figure 1 on the left, the label 1 prepared so far is inserted in the bottom section 20 of an injection mould (also see figure 5). Also shown are integrated-circuit elements in the form of semiconductor chips 2, 2′ or electronic modules 12, 12′. As indicated again in figure 1 only, on the right, these elements have been furnished separately and are inserted in the injection mould over the label 1. Their contact means or bond pads (4′ in figure 1) are accurately positioned by means of a manipulator (not shown) to fit over and contact the terminals of the coupling means. The aforesaid procedure also applies to the various other embodiments described below in conjunction with figures 2 to 4.

In the case of figure 1, a coil for inductive coupling is wound as a flat wire coil 3. The coil is rectangular in shape to suit

the card format and is glued to the label 1 along the label's edges. The "underside" of the chip 2 shown separately on the right has bond pads 4' as contact means for the coil 3. The chip may, for example, be a single chip whose integrated circuit performs all the card's functions, including, via the coil 3, data communication and the supply of electrical energy to the circuitry. The electrical connection of the coil's ends to the chip 2 can be made, as shown, by means of terminals 4, if necessary across a wire bridge 5, wherein the terminals 4 are on the label and contact-bonded to the aforesaid bond pads 4' of the chip 2. In addition, the chip 2 may be attached to the label 1 by means of adhesive.

In the embodiment shown in figure 2, a coupling coil 6 with the requisite number of windings has been created as a printed circuit on the label 1. The known technique can at the same time also be used to make the coil ends 7 suitable for direct contact-bonding to a chip 2. It may be desirable to place the chip across the windings of the coil 6, as shown, to dispense with special means to lead one of the coil ends across. If the surface of the chip 2 that faces the coil is provided with an insulating passivating layer, no further action is required; but if necessary an insulating coating may be applied to the coil 6 before the chip 2 is applied.

In the embodiment shown in figure 3, a coupling coil 6 is again applied to the label 1 as a printed circuit that more or less makes use of the entire card format. At the same time, the same technique has been used to create two conductive areas 8 within the coil area as capacitor layers for capacitative coupling. In this case an integrated circuit (chip 2) is contained within a flat electronic module 12. This has contact means or bond pads in the form of module terminals 13 for contact-bonding to the two coil ends and the capacitor coatings 8, and is preferably again placed to bridge across the coil windings 6.

The card's integrated-circuit elements need not be concentrated in a single chip or module, but may be split among two or more such components in a known manner. If so, it may be useful to

apply printed circuits to the label for connecting the aforesaid components to one another and/or to the coupling means. Figure 4 shows a typical embodiment of this kind, and in this case of a chip card designed not only for non-contact operation but also suitable for direct electrical contact. Accordingly, figure 4 shows a module 12' with contacts 15 and a separate chip 2' placed inside the area of a printed coil 6 on the label 1.

Chip 2' may, for example, be a so-called communication chip that performs the functions of non-contact data transfer and, if necessary, the supply of electrical energy to the card's circuitry. As shown, this chip may be directly connected to one end of the coil and across a wire bridge 5 to the other. The electronic module 12' is of an especially flat design whose contact area 15 forms part of one of the card's outer surfaces for electrical connection to a card reader (similar to the module described, for example, in EP-A-0 599 194). The external contacts 15 have angled "feet" 16 that bear on the label 1. Further, the module 12' has other contacts 17 not accessible from outside. These are contact-bonded to the printed circuit strips 14 on the label and provide the connections between the module 12' and the chip 2' (see also figure 5) either across these or, if no separate communication chip is provided, directly with the coupling means. Obviously, if necessary, additional strip conductors 14 can provide for further connections between the communication chip 2' and the module 12'.

The coupling means on the label can obviously be designed to suit the card system's requirements; in particular, for example, two coupling coils may also be placed next to each other. Although the typical embodiments shown in figures 1 to 4 refer to a single label 1, if each of a pair of labels forms one of the card's two outer surfaces, it is also possible to provide both labels with coupling elements. For example, one or more coils may be applied to one of the card's labels, and capacitor layers to the other, or both labels may each have a capacitor layer, and so on. In that case, in order to contact-bond to the coupling means, the integrated-circuit elements on both sides

must be provided with the requisite bond pads or module terminals.

As stated, the prepared label(s) (in some cases only one per card) and the integrated-circuit elements are introduced after one another into an injection mould. Figure 5 shows such a mould diagrammatically, made up of two half-moulds 20 and 21, with a sprue 22 in the parting plane. The embodiment shown is based on a prepared label as described for figure 4. In the mould 20, 21, this is the lower label 1a, and a second label 1b is laid into the upper half-mould 21. In established practice, this upper label 1b has a rectangular cut-out 18 occupied by the contact area 15 of the module 12'. The module's other contacts 17, on the other hand, are not exposed on the card's outer surface but are covered by the lower label 1a.

Finally, when the label(s) and integrated-circuit elements have been assembled and the mould closed (for example as in figure 5), the body of the card is formed by the injection-moulding process, by injection of plastic to fill the void 23 formed in the mould. In this process the injected material bonds to and combines with the inner surface of the label(s), and at the same time envelops the integrated-circuit elements and embeds them in the body of the card. The chip card now contains all the components necessary for non-contact use and can be taken out of the mould.

Various processes known per se are available for forming electrically conductive connections between the integrated-circuit elements and the coupling means and/or strip conductors within the injection mould. One possibility is to make the connections by local application of electrically conductive adhesive. But it is also possible to make direct metal-to-metal connections simply by mechanical contact pressure, if necessary with the support of ultrasonic welding. As the embodiment in figure 5 shows, if a module 12' is used that takes up practically the whole card thickness, its terminals 17 are pressed against the strip conductors 14 in the closed mould 20, 21, and this promotes contact-bonding inside the mould. In this context,

in order to make the connections one can exploit the strong forces applied during injection moulding upon the inserted components as a result of the high pressures in the plastic moulding material. For electrical contact-bonding one can also take advantage of the high temperatures that occur in injection moulding, for example by the use of an adhesive that reacts to heat and sets in the mould, or by the simultaneous application of pressure and high temperature, so-called thermocompression, for metal-to-metal bonding. Finally, it is also possible to ensure electrically conductive connections by the use of portions of soft solder (solder preforms) that melt in the injection mould.

Amended Claim 1

1. Method for the manufacture of a chip card that contains inductive and/or capacitive coupling means (3, 6, 8) for the non-contact transmission of electrical energy and/or data, integrated-circuit elements (2, 12) connected to the coupling means in the form of at least one chip and/or electronic module,

- whereby at least one outer surface of the card is formed by a label (1), whereby the aforesaid coupling means (3, 6, 8) are applied to the surface of said label (1) that faces away from the outer surface which is printed or to be printed;
- whereby the label (1) thus prepared is inserted into an injection mould (20, 21);
- whereby the separately furnished integrated-circuit elements (2, 12), which provide contact means (4', 13) for said coupling means (3, 6, 8), are inserted into the injection mould (20, 21) above the label (1), said contact means (4', 13) thereby accurately positioning over terminals (4, 7) of the coupling means and contacting with said terminals (4, 7);
- whereby the body of the card is then formed and bonded to the label (1) by an injection-moulding process whereby at the same time the integrated circuit elements (2, 12) are embedded in the body of the card; and
- whereby electrically conductive connections between said coupling means (3, 6, 8) and said integrated-circuit elements (2, 12) are formed within the injection mould (20, 21) by mechanical contact pressure, electrically conductive adhesive, and/or low-melting-point soft solder.

2. Method in accordance with claim 1, wherein at least one coil for inductive coupling is applied to the label (1) in the form of a flat-wound wire coil (3).

3. Method in accordance with claim 1, wherein the coupling means (6, 8) are formed on the label (1) in the form of a printed circuit.

4. Method in accordance with claim 3, wherein a chip (2) or an electronic module (12) is positioned across the windings of a printed coil (6) and the outer and inner end terminals of the coil are contacted therewith.

5. Method in accordance with one of the preceding claims, wherein printed strip conductors (4, 14) are applied to the label (1) for the connection of the coupling means (3, 6, 8) to integrated-circuit elements (2, 12) and/or of integrated-circuit elements to one another.

6. Method in accordance with one of claims 1 to 5, wherein a thermoreactive (thermosetting) conductive adhesive is used for obtaining electrically conductive connections.

7. Method in accordance with one of claims 1 to 5, wherein contact-bonding in the injection mould is suppported by ultrasonic welding.

8. Method in accordance with one of claims 1 to 5, wherein contact-bonding in the injection mould is obtained by thermocompression, i.e. by the simultaneous application of elevated temperature and pressure.

9. Method in accordance with one of claims 1 to 5, wherein contact-bonding in the injection mould is obtained by the use of pre-formed portions of soft solder.

10. Method in accordance with one of the preceding claims, wherein an electronic module (12') is used that has an externally accessible contact area (15) and further terminals (17) for connection to the coupling elements.

Fig. 1

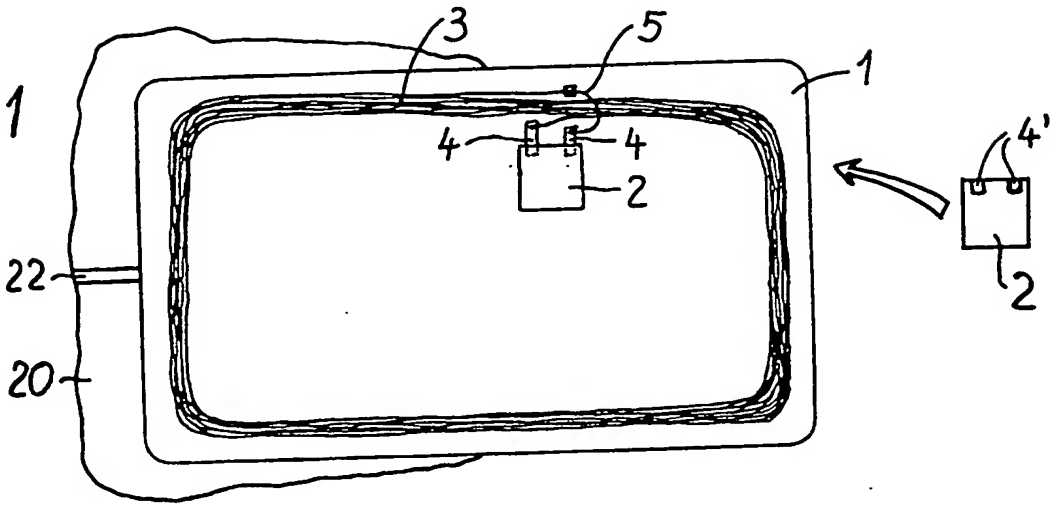


Fig. 2

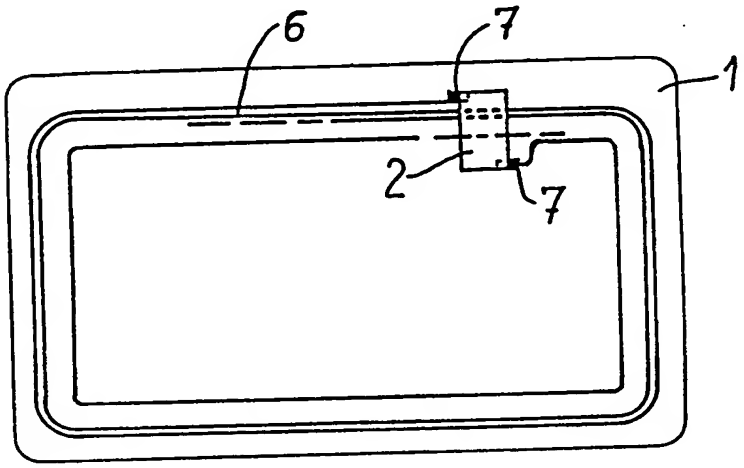


Fig. 3

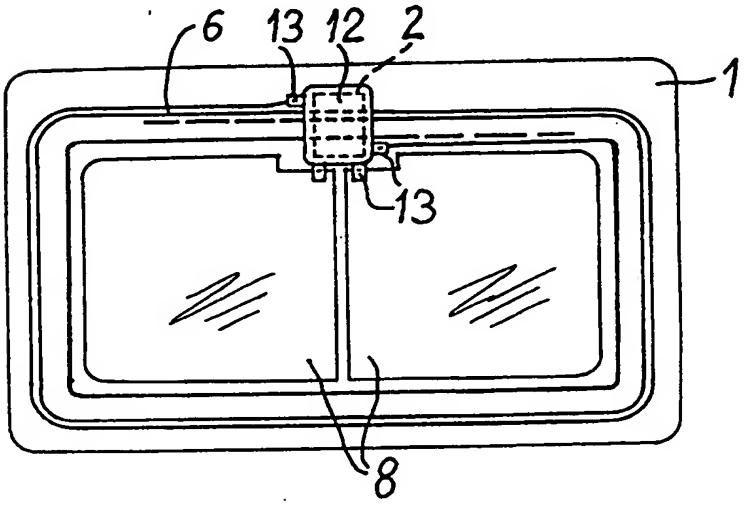


Fig. 4

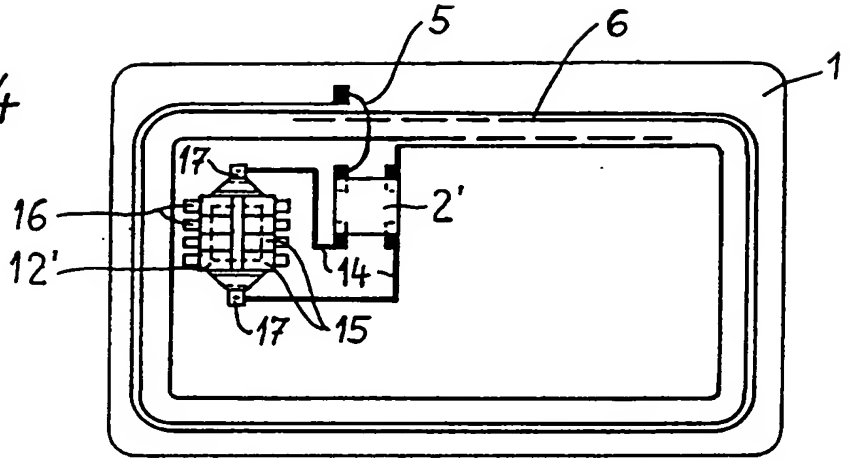
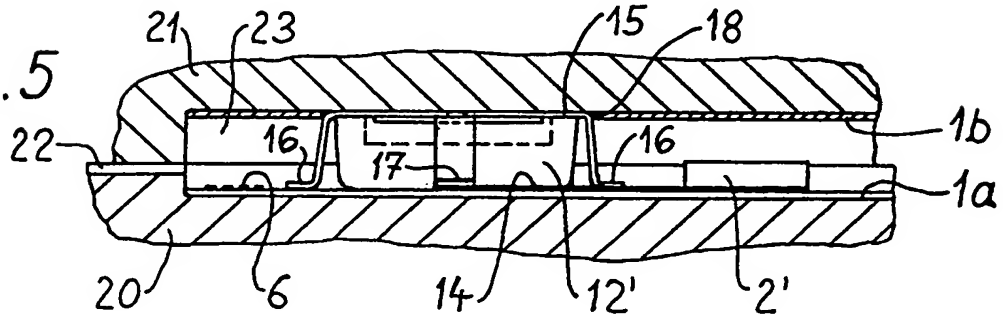


Fig. 5



Abstract

In the chip cards to be manufactured, integrated-circuit elements (chip 2 and/or electronic module 12), coupling means (coil 6, capacitor layers 8) for the non-contact transmission of electrical energy and/or data transfer, and at least one label (1) which forms an outer surface of the card are presupposed. The coupling means (6, 8) are applied to the inner surface of the said label. The label (1) thus prepared is then introduced into an injection mould. The separately furnished integrated-circuit elements (12) are then positioned in the injection mould to fit exactly over and to contact the terminals of the coupling means (6, 8). Finally, the body of the card is moulded and bonded to the label by an injection-moulding process and at the same time the integrated-circuit elements are embedded in the body of the card. Electrical connections between the coupling means (6, 8) and the integrated-circuit elements (12) are made in the mould itself by various means.

(Figure 3)